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SOILAGE *AND* SILAGE *FOR MILK PRODUCTION*

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ON THE COVER . . .

Fig. 1.—Field Chopper and Cross-conveyor Wagon Used to Deliver Fresh Grass Twice Daily.

SOILAGE AND SILAGE FOR MILK PRODUCTION

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Utilization of meadow crops in this country has progressed continuously through greater degrees of intensity from continuous grazing of permanent pastures through continuous grazing of utility meadows, followed by rotational grazing, strip grazing (or close folding), field chopping and dry lot feeding of fresh grass (soilage). Some dairymen have abandoned soilage in favor of summer feeding of silage. Many dairymen adopted the more intensive practices before finding whether or not the increased milk production would recompense for greater cost of production.

This study is concerned chiefly with a comparison of milk production of cows fed legume-grass forage both as soilage and silage under practical management procedures. Other factors deserving consideration in choosing a forage system are fencing costs, distances of fields or pastures from barns or feedlots, level of soil fertility, land values and availability of shade, water, farm equipment and labor.

REVIEW OF LITERATURE

The degree of intensity of utilization of meadow crops varies from pasturing exhausted unfertilized pastures of our northeastern states to picketing of cattle on lush pastures of Holland. Peer (26) described the soiling method as practiced on his farm in southern New York by which he nearly doubled the milk production per acre. He harvested twice daily and fed five times per day. Lane (19) in 1902, Kildee (17), Billings (3), McCandlish (22), Frandsen **et al.** (11), and Woll **et al.** (30), reported on successions of crops that provided soilage continuously from spring to fall.

Vorhees (29) showed a phenomenal decrease in the area of land required to support a cow when the soilage system is adopted. Billings (2) speaking to the Ohio Dairymen's Association in 1909 and consider-

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ing normal crop yields predicted that the carrying capacity of 120 acres of cropland could be increased from 27 cows and replacements to 41 cows and replacements, a 50% increase by adoption of soiling. Henderson **et al.** (14) showed experimentally that milk production **per acre** was 41% higher on soilage than on pasture. Gullickson **et al.** (13) unlike Henderson **et al.** (14) found about the same production **per cow** on soilage and pasture. Gullickson **et al.** (13) were able to maintain their experimental herd on 30.6 acres of soilage in contrast with 50.9 acres of pasture. Oregon workers (1) summarized farmer opinion to conclude that both green chop and all-silage were better than pasturing. Hoglund (15), however, said in 1956 that "most dairymen will gain most from improving the grazing practices they now use".

Myers (25) emphasized that efficient use of land taken out of pasture is needed if net income is to be increased. That was accomplished by plowing pasture land for corn which yields large amounts of dry matter per acre. Many of the earlier reports on soilage compared it with corn silage (3, 11, 22, 30). Alfalfa ranks high in respect to acre yields of dry matter and Frandsen and co-workers (11) among others had included it in a recommended succession for soilage purposes. Bull and Carroll (5) as late as 1937, however, did not suggest alfalfa as the main soilage crop.

Kildee (17) considered labor requirements of making soilage to be the main deterrent to adoption of the soiling system. Later Kildee **et al.** (18) stated that "the man with only five or six cows finds that his small herd does not justify a silo. Under such situations a soiling system readily adapts itself". Now a five or six cow herd is not considered to be an economical unit due to increase in wages and to high cost of machinery. Kildee **et al.** (18) stated the case for the silo by saying "When a summer silo is used the dairyman is independent of these seasonal changes because the feed is supplied the previous year. This steady supply adds stability and security so that a man can adjust his number of cows accordingly and insure against a feed shortage".

The development of the Ronning harvester in 1913 is recounted by DeLong (7) who pointed out that the sales of field choppers increased from 437 in 1944 to 19,357 in 1949, a 44 fold increase! Field chopping has made daily harvest much easier, however, the overhead cost determines the size of herd for which soiling becomes profitable. Myers (25), Eichers and Engene (9) and Hoglund (15) have analyzed the economics of soiling compared with summer silage. Frandsen **et al.** (11), Sprague (28), Gullickson **et al.** (13), Donker (8), and Kildee **et al.** (18) have analyzed other factors involved in a comparison of soiling and silage.

Many of the experiments demonstrating the utility of soilage contained uncontrolled variables which in the light of modern experimental techniques make the conclusions doubtful.

A knowledge of comparative costs of feeding dairy cows by bunk feeding of soilage and silage are vital to future economy. Likewise information on the returns in milk production from the two systems on the **same** crop is vital. Foreman **et al.** (10) have compared alfalfa silage and chopped green alfalfa using a double reversal experiment and 15-day periods. The use of 15-day periods may be questioned since it is known that rumen flora require approximately three weeks to adjust after some changes in ration. The change from grass to silage or vice versa may not have as great an effect on the flora as changes involving shifts in grain intake, however, they found that cows fed soilage ate more dry matter and produced more milk. They also found that cows fed silage were more efficient in converting nutrients to milk.

THE PROBLEM

This two-year experiment was designed to compare freshly chopped grass-legume meadow crop with silage made from a similar crop ensiled after being wilted, and without preservatives. The intention was to harvest the two kinds of forage during the range of times when farmers would have to harvest for this purpose.

EXPERIMENTAL PROCEDURES

1957

Twenty-four Jersey and six Holstein cows were divided into six comparable groups with respect to breed, age, weight, past production records and current milk production (F. C. M.) as shown in Appendix I, and assigned to groups at random. Only late winter or early spring freshening cows were used so that they would maintain a reasonable level of milk production from early May to September. Table 1 shows the assignment of groups to soilage and silage and to the three levels of grain feeding.

The grain ration consisted of equal parts by weight of ground oats and ground ear corn and contained 11.18% total protein.

Silage

The silage fed until July 27, 1957 was made from the first cutting of an alfalfa-brome mixture on June 11-12-13, 1956. This was fed to groups 1, 3, and 4 while groups 2, 5, and 6 were fed concurrently with

TABLE 1.—Assignment of Cow Groups* to Soilage and Silage and to Levels of Grain Feeding. 1957

Treatment	Age	Weight	Daily Production†	4% F. C. M.	
				Actual	Mature Equivalent
	(yrs.–mos.)	(lb.)	(lb.)	(lb.)	(lb.)
Soilage					
Groups 2, 5, 6 Av.	5–6	930	40.2	9,328	10,488
Silage					
Groups 1, 3, 4 Av.	5–7	933	40.3	9,465	10,645
No Grain					
Groups 1, 2 Av.	5–6	939	42.8	9,347	10,454
Half Grain‡					
Groups 3, 5 Av.	5–2	923	39.1	9,128	10,475
Full Grain§					
Groups 4, 6 Av.	6–0	934	38.9	9,715	10,772

*The data for individual groups are given in the Appendix I.

†Prior to experiment.

‡These were fed at one-half the rate of Groups 4 and 6 above.

§Holsteins were fed 0.4 lb. of grain for each lb. of milk above 20, while Jerseys were fed 0.5 lb. of grain for each lb. of milk above 12.

first growth of a similar crop that was cut as soilage. Other first cutting alfalfa-brome was ensiled from June 4 to 10 for feeding "silage" groups concurrently with the second growth of alfalfa-brome to the opposing groups. All of these cuttings were from fields of alfalfa-brome mixtures that were 50% or more alfalfa.

Soilage

Most of the crops cut for green feeding were mixtures of alfalfa and bromegrass. The alfalfa usually made up one-half or more of the mixture. A first growth of a mixture of grasses, birdsfoot trefoil and Ladino clover were used for one week to supplement the second cutting of alfalfa-bromegrass.

The soilage was cut twice daily with a field chopper into a trailed wagon with cross conveyor (Cover) for delivery to the stable where the cows were fed in individual mangers. The practice of twice-daily-chopping was adopted to avoid possible effects of heating on soilage consumption.

Analyses

Grain samples were analyzed for dry matter content to make possible a relation of total ration dry matter intake to milk production.

Each load of cut forage was sampled at ensiling and the silage was sampled three times a week at feeding time. Kilogram samples of each load were enclosed in nylon mesh bags and placed on top of the corresponding silage in the silo while duplicate samples were analyzed as fresh material. Moisture determinations of silage were made by the Toluene method.

Daily harvests of soilage were sampled for dry matter content and the dried samples were composited for proximate analysis. The pooled refusal of soilage from the mangers was sampled daily for dry matter content.

Digestion Trials

Digestion trials were conducted at appropriate intervals to determine digestibility of dry matter and utilization of nitrogen at different stages of growth of soilage in contrast with silage.

Experimental Period

Both experimental groups were fed their respective forage from May 14 (when the soilage was large enough for field chopping) to September 16, a period of 125.5 days.

Feeding Procedure

Grain was fed at about 6 A. M. during the milking period and at about 4 P. M. Silage and soilage were fed to the respective groups after the grain was eaten and in such amounts that some would be refused. When refusal amounted to 5 pounds, that cow's allowance was reduced. If the refusal was less than 1 pound the allowance was increased.

1958

Thirty cows were again divided into five groups of six cows each which were assigned at random to one of six groups with the uniformity comparable to that obtained in 1957. Grain feeding was on the same basis as in 1957.

The silage fed from May 15 until July 25, 1958 was second-cutting alfalfa-bromegrass cut on July 25 to 29, 1957, wilted, and ensiled without a preservative. On June 3, 1958 a silo was filled with first cutting alfalfa-brome (wilted but with no preservative). This was fed from July 25 to September 17. The cows were allowed more refusal than in the previous year.

Soilage was cut from the same fields as during the previous year. The nature of the crop is best described by analyses and digestibility figures presented in the experimental results. Again the soilage was cut twice per day.

The same plan was followed in feeding the animals and weighing back refusal as in 1957. Shavings were again used for bedding to minimize errors in the feeding procedure.

RESULTS AND DISCUSSION

The average dry matter content of the grass-legume mixture ensiled in June, 1956 for feeding in the early part of the 1957 season was 32.5%. When wilting progressed satisfactorily the dry matter content varied from 45 to 55%. When the weather was cloudy or rainy and wilting ceased five loads varied from 12.5 to 15% dry matter. The average protein content was 12.06% and crude fiber 22.13% on a dry matter basis. The percentage recovery of dry matter from kilogram samples of each load of ensiled material packaged in nylon mesh bags and placed on the corresponding load in the silo, averaged 86.5%.

One load that went into the silo contained 32.4% dry matter which was the average for the entire silo. When this silage was removed it had a pH of 4.6. Determination of total organic acids showed that 41.84 ml. of 0.01 N alkali were required to neutralize the acids from 1 ml. of silage juice. Of the total organic acids 36.7% were lactic, 50.4% acetic, 4.9% butyric, 4.2% propionic and 3.8% undetermined acids. Of the volatile fatty acids as determined by chromatogram acetic made up 84.7%, butyric 8.2%, and propionic 7.1% of the total. Of this particular sample 93% of the ensiled dry matter was recovered from the silage.

On June 4-5-6 the wilted crop from five 3-acre fields ensiled for feeding in July and August varied in dry matter content from 18 to 33.5%. A composited sample of the silage contained 11.5% crude protein.

In 1957 the silage fed during the first half of the experimental period was made from first growth of an alfalfa-brome mixture ensiled in June, 1956. During the second half the silage was that which had been made in early June, 1957 from first growth. In July, 1957 a second growth was ensiled to be fed during the first half of the 1958 season. In June of 1958 a first cutting was ensiled to be fed during the second half of the exeriment. Thus a procedure was followed that would have been necessary in summer silage feeding in commercial dairy production. These differences in the seasonal origin of silage (or failure

of silage to be contemporary with soilage) may account for the greater divergence in milk production between groups fed soilage and those fed silage in the latter half of the 1957 season than in the 1958 season. The averaged results of the two seasons make a valid comparison of the two forages.

Composite samples made of the daily harvests of green-chopped material throughout the experiment averaged 16.7% dry matter of which 16.27% was crude protein.

The average forage dry matter intake, total dry matter consumption and daily production of 4% fat-corrected milk (F.C.M.) are given in Appendix III for each of the six groups. It will be noted that in 1957 the production on grass without grain was higher than for silage at any level of grain feeding. The differences in milk production between groups fed grain and those fed no grain are statistically significant although the differences between the two groups fed grain are not significant. The feeding of grain resulted in substituting grain dry matter for some roughage dry matter although the total dry matter of the ration increased with grain feeding.

Analysis of weight changes from May 14 to September 16, based upon averages of three successive days weights at both the beginning and end of the experiment, show an average forage difference of 93 pounds which is a statistically significant difference. Differences in weight changes at the **no grain** and **full grain** levels between silage and grass are apparent; however, the differences are not statistically significant.

Digestion trials of five days duration were carried out beginning on May 27 and again on June 10. Table 2 (1957) shows greater digestibility of both protein and dry matter of grass compared with silage. Although grain feeding increased slightly the digestibility of dry matter of the ration containing soilage, it increased that containing silage significantly. The full rate of grain feeding was required to bring the digestibility of dry matter of the silage ration to the level approaching that of soilage alone. The higher digestion coefficients for soilage which was predominantly alfalfa indicate the suitability of the alfalfa crop for this purpose making the use of protein concentrates unnecessary when soilage is cut at a proper stage.

The digestibility of the protein of the soilage ration was not increased by grain feeding. The protein of soilage was about one-fifth more digestible than that of silage.

TABLE 2.—The Effect of Roughage and Level of Grain Feeding on Digestibility of Protein and Dry Matter and on Digestible Dry Matter Intake. 1957

	Digestibility		Digestible Dry Matter Intake
	Dry Matter	Protein	
	(%)	(%)	(lb.)
Soilage			
No grain	65 2	78.6	18.13
Half grain	66.5	75.8	19.68
Full grain	66.8	74.0	21.71
Silage			
No grain	56.0	63.6	10.53
Half grain	61.8	65.6	12.85
Full grain	64.5	63.5	14.58

1958

As in 1957, records were kept of feed intake of the experimental cows for a 2-week period and their production was used as one criterion for dividing them into six comparable groups. Their production in the preliminary period is indicated as the initial production in Figure 2 whch presents the trends in production in six groups for both 1957 and 1958. Appendix II and IV present the milk production and ration dry matter data for 1958 by 2-week periods and for the entire experiment, from May 15 to September 18 inclusive—a period of 126 days. The milk production of the groups on soilage is significantly higher at the 1% level than those on silage, however, the difference is primarily between the no-grain groups, the forage differences between groups fed grain not having statistical significance. The increase in milk production due to increasing grain from one-half to the full grain level is not significant confirming the data of 1957.

The combined data of 1957 and 1958 on F. C. M. appears in Table 3 showing the effect of forage to be highly significant. The linear effect of grain feeding at the one-half grain level on milk production is also significant.

The cows fed soilage had a significantly higher intake of dry matter than those fed silage as shown in Appendix III. Feeding grain at the half level increased dry matter intake significantly. The feeding of grain at the full grain level did not increase total dry matter intake

TABLE 3.—4% F. C. M. and Net Weight Change Per Cow Per Day During 1957 and 1958

Treatment	Pounds Milk			Net Weight Change, lb.		
	Silage	Soilage	Av.	Silage	Soilage	Av.
No grain	22.7	30.5	26.6	—57	+13	—22
Half grain	28.7	34.8	31.8	—53	+36	— 8
Full grain	30.5	34.1	32.3	—13	+40	+14
Av.	27.3	33.2		—41	+30	
	5%	1%	C. V.	5%	1%	
L. S. D. Forage	1.6	2.6	7.2%	39	65	
Grain	4.0	N. S.	18.2%	N. S.	N. S.	
Forage x Grain	N. S.	N. S.	15.0%	N. S.	N. S.	

significantly beyond that of the half grain level. These data for 1957 are confirmed by the combined data of 1957 and 1958 as seen in Table 4.

When no grain was fed the dry matter intake of the cows fed soilage was significantly greater than when silage was fed. Evidently feeding grain at the half level increased total ration dry matter intake but increasing the grain allowance to the full grain level resulted in a substitution of grain dry matter for forage dry matter.

TABLE 4.—Forage Dry Matter and Total Ration Dry Matter Per Cow Per Day During 1957 and 1958

Treatment	Pounds Dry Matter Consumed					
	Forage Only			Total Ration		
	Silage	Soilage	Av.	Silage	Soilage	Av.
No grain	20.0	28.2	24.1	20.0	28.2	24.1
Half grain	20.9	26.5	23.7	24.2	30.5	27.3
Full grain	18.6	24.5	21.6	25.5	32.1	28.8
Av.	19.8	26.4		23.2	30.3	
	5%	1%	C. V.	5%	1%	C. V.
L. S. D. Forage	2.2	3.6	13.0%	2.8	4.7	22.3%
Grain	2.0	N. S.	11.9%	2.9	N. S.	11.3%
Forage x Grain	1.5	N. S.	6.3%	N. S.	N. S.	

The average difference in body weight change in 1957 of the no-grain group during the experimental period was 93 pounds due to forage and is highly significant. There were no significant differences in weight change due to grain feeding. These conclusions are confirmed by the combined data of 1957 and 1958 shown in Table 3. However, the digestion trials indicated that the weight changes were physiologically significant even though they were not statistically significant.

Of the 30 cows fed soilage during the two experimental periods 28 conceived with an average of 1.75 services per conception. Of the 30 fed silage 26 conceived from an average of 1.96 services per conception. The numbers of cows are not large enough to draw definite conclusions regarding the effects of forage upon fertility, especially as it was impossible to remove other variables.

Five digestion trials were carried out during 1958 using one Jersey cow from each group. The data on dry matter digestibility appear in Table 5. The silage fed on September 16 was cut for ensiling on June 3, 1957, that fed August 19 was cut June 12 and that fed July 22 was cut on June 16. The decline in dry matter digestibility with advance in stage of growth is evident. Likewise, it is evident that the dry matter of the green feed was more digestible in each trial than that of silage. The low digestibility of the grass during the trial starting June 24 is due to the advanced stage of growth of the first cutting alfalfa and brome that was fed.

TABLE 5.—Digestibility of Dry Matter of Silage and Soilage in 1958

Roughage	Grain	May 26*	June 24	July 22	Aug. 19	Sept. 16	Av.
				(% Digested)			
Silage	None	53.8	53.4	55.1	56.2	57.8	55.3
	Half	57.8	58.5	61.0	59.1	55.5	58.5
	Full	59.0	58.4	64.5	60.4	60.5	60.6
Soilage	None	67.7	56.0	65.2	65.1	64.5	63.5
	Half	69.4	59.4	74.3	70.3	72.3	69.1
	Full	68.5	63.3	70.6	65.8	71.2	67.5

*The 5-day digestion trials began on the dates indicated.

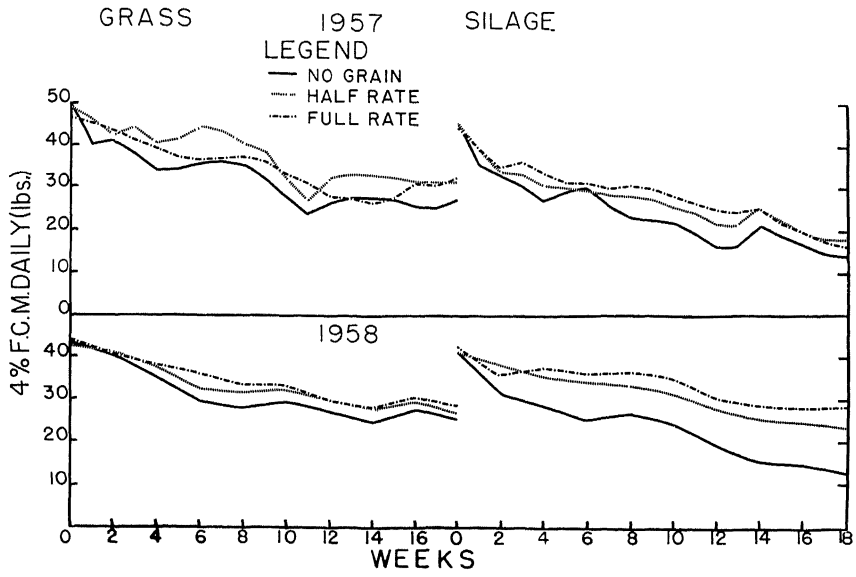

Fig. 2.—Seasonal Trends of 4% F. C. M. Produced by Groups Fed Fresh Grass and Silage with No Grain, Half Rate and Full Rate of Grain Feeding.

As pointed out in the discussion of the data of Appendix III the differences in milk production and in the total dry matter intake of the two forages were highly significant thus confirming the work of Foreman (10). Apparent variations in response in milk production (Fig. 2) between 1957 and 1958 suggested making an analysis of the combined data for the two years which appears in Table 3. Differences due to forage were highly significant. There were no significant differences between levels of grain feeding and no soilage-grain interaction. In an effort to determine the importance of these effects an analysis of covariance was computed on milk production adjusted by regression to standard production of the preliminary period and for digestible dry matter intake (calculated from dry matter intake and coefficients of digestibility). The digestible dry matter intake accounted for 33.46% of the variation in adjusted milk production. The correlation between adjusted milk production and digestible dry matter of the ration for the groups fed grain is 0.73 while that of the no grain groups was only 0.38. In this analysis the treatment effects were broken down into soilage, grain and soilage-grain interaction. Neither soilage nor soilage-grain

interaction was significant. The grain rations were significant and account for most of the differences between treatments. Because grain treatments were at three levels, zero, half and full allowance both linear and quadratic effects of grain level were computed. The milk production responded to addition of grain (linear effect) but did not increase further when grain was increased from the half to full level. The adjusted grain means were for zero grain 27.41 pounds, for half grain 31.43 and for full grain 31.78 pounds. At the higher grain level digestible dry matter of grain was evidently substituted for that of forage. The higher (non-adjusted) milk yields from soilage in Appendix IV were evidently due to higher **digestible** dry matter intake.

GENERAL DISCUSSION

Summarization of the amount of milk produced after this experiment ended in both 1957 and 1958 showed that the cows on silage produced an average of 1567 pounds of 4% F. C. M. while those on soilage produced 2518 pounds or 950 pounds more. The cows fed silage produced for 91 days after the experiment ended while those on soilage produced for 104 days.

In both 1957 and 1958 change of the ration from soilage to silage at the start of the experiment resulted in marked reduction in milk flow. The decrease in readily fermentable carbohydrate of the silage by anaerobic fermentation undoubtedly is partially responsible. Marked reduction in dry matter intake is another accountable reason. Huffman **et al.** (16) found that immature alfalfa soilage and alfalfa-molasses silage (made with 5% molasses) were equally valuable in replacing hay in an all hay ration or grain in a hay-grain ration. This so-called "grain factor" appears to be the **energy** of the unfermented digestible carbohydrates of the alfalfa and of the molasses of the alfalfa silage. Brown (4) stated at the International Dairy Congress of 1959 that "The limiting factor for further increase in yield from an all-silage diet appears to be the level of starch equivalent, not digestible crude protein". Murdoch (24) likewise postulated that when grass silage is fed without concentrates milk production would be limited by the starch equivalent or energy supplied by the silage.

Data on machine and man hours for green chopping and silage making in this experiment would have very limited application in farm practice as much of the crop was cut in 3-acre lots where the cost would be excessive compared with that harvested in large fields. The reader

is referred to the work of Eichers and Engene (9) for discussion of the variables affecting the cost of nutrients from soilage and silage. Shaudys, Sitterley and Evans (27) have shown by a survey of farms which used the two programs that 350 to 400 pounds of extra milk must be produced per cow to meet the extra costs of soilage feeding. In this experiment about 900 extra pounds of milk were produced by the group fed soilage and no grain.

In this experiment in 1958 for those groups fed no grain there was practically the same milk production per pound of dry matter eaten from both roughages. For this experiment the advantages in favor of soilage are (1) that 13.5% of the ensiled dry matter was not recovered after ensiling and (2) that a cow ate a half more dry matter and produced one-third more milk without additional maintenance requirement. The average cow weight was 887 pounds. At Morrison's standard the maintenance requirement would be 7.03 pounds of total digestible nutrients and the saving of one-third or 2.34 pounds of nutrients would be adequate to produce 7 pounds more milk. One advantage in favor of silage is the greater efficiency in use of labor when the entire crop can be harvested consecutively; another is freedom from the necessity of harvesting during inclement weather.

The experiences gained in this experiment indicate that if the practice of soiling is being followed and the crop available for soiling is running short, supplements in the form of hay or silage should be offered gradually so that the transition is not abrupt.

Surplusses of soiling crops that are cut for silage should be cut at the stage of growth when it is still palatable to the cow. To wait until later for increase in the tonnage will result in increased lignification and decreased digestibility of dry matter.

SUMMARY

In 1957 and again in 1958, 24 Jerseys and 6 Holsteins were divided in two similar groups of 15 cows each and were fed alfalfa-brome silage or soilage. Both groups were subdivided to feed three levels of grain (zero, half and full).

Soilage-fed cows ate about one-half more dry matter and produced a third more milk than those fed silage made from a similar crop harvested at about the same average stage of growth. These differences in dry matter intake and milk production were highly significant. When no grain was fed the soilage-fed cows produced over 900 pounds more milk than the silage-fed cows during 126 days.

Coefficients of digestibility of the dry matter determined with Jersey cows of each group showed the dry matter of soilage to be 63.5% digestible as compared with 55.3% on silage. Addition of grain at the half level raised the coefficient for silage to 58.5% and at the full grain level to 60.6%. Coefficients of digestibility of protein of fresh grass were 78.6% as compared with 63.6% for silage. Grain feeding did not alter the digestibility of protein appreciably for either the grass-fed or silage-fed groups. The **digestible** dry matter intake of the grass-fed cows was 56% greater than that of the silage-fed cows.

The greater yield of 4% F. C. M. due to soilage was highly significant because of the greater intake of digestible dry matter. Grain feeding definitely increased milk yield but no statistically significant difference was found between half and full grain groups. The differences in weight changes from the beginning to the close of the experiment on both soilage and silage between the levels of grain feeding were not significant.

Cows fed the full rate of grain substituted grain dry matter for either soilage or silage dry matter while feeding at the half rate resulted in increased dry matter intake.

Cows fed soilage maintained milk flow to the end of the experimental period of 18 weeks at a higher rate than did those fed silage and produced an average of 950 pounds more after the experiment and before the lactation was completed.

There appears to be no difference in the conception rate due to the forages fed.

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APPENDIX I.—Data Used in Grouping the Cows. 1957

Cow No.	Age	Weight	Daily Production	4% F. C. M.	
				Actual	Mature Equivalent
	(yrs.-mos.)	(lb.)	(lb.)	(lb.)	(lb.)
Group 1					
J 1208	3–7	860	37	7,803	9,754
J 1229	3–2	825	29	6,693	8,567
J 1090	6–5	905	36	11,899	12,018
J 1008	9–3	933	46	9,448	9,448
H 1154	4–9	1323	66	11,648	13,045
Average	5–5	969	42.8	9,498	10,566
Group 2					
J 1215	3–6	813	30	5,074	6,443
J 1323	3–3	718	28	7,962	10,032
J 1054	7–2	1015	50	8,203	8,203
J 1010	9–2	858	42	10,114	10,114
H 1155	4–9	1135	64	14,622	16,815
Average	5–7	908	42.8	9,195	10,341
Group 3					
J 1234	3–2	708	36	6,616	8,336
J 1204	3–8	852	26	8,595	10,658
J 1137	5–1	798	44	12,301	14,146
J 1127	5–3	928	34	7,010	7,431
H 1083	6–6	1360	56	11,269	11,720
Average	4–9	929	39.2	9,158	10,458
Group 4					
J 1242	3–1	723	30	6,098	7,805
J 1209	3–7	748	35	9,205	11,782
J 1105	5–10	825	40	9,692	10,972
J 898	11–3	958	41	10,487	10,592
H 1016	9–2	1248	49	13,407	13,407
Average	6–7	900	39.0	9,738	10,912
Group 5					
J 1227	3–3	676	36	7,531	9,564
J 1134	5–2	984	40	8,591	9,880
J 1080	6–8	780	36	8,366	8,533
J 960	9–4	976	39	11,127	11,350
H 1222	3–3	1164	44	9,869	13,126
Average	5–6	916	39.0	9,097	10,491
Group 6					
J 1232	3–2	838	32	7,889	10,019
J 1129	5–2	905	32	10,269	10,988
J 1100	6–1	945	37	9,399	10,809
J 1048	7–3	880	33	6,121	6,121
H 1106	5–10	1268	60	14,778	15,221
Average	5–6	967	38.8	9,691	10,632

APPENDIX II.—Average Pounds Milk Produced Daily and Pounds Dry Matter Intake for Groups of Cows on Silage and Soilage at Three Levels of Grain Feeding. 1958

Roughage →		Grass			Silage		
Level of Grain →		Zero	Half	Full	Zero	Half	Full
		(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)
Period (2 wk. each)							
1	4% milk	40 2	41.1	40.6	31.2	38 1	35.1
	Forage D. M.	27 1	26.4	22.9	19.5	23.1	20.8
	Grain D. M.	____	4.6	11.3	____	4.4	8.9
	Ration D. M.	27.1	31.0	34.2	19.5	27.5	29.7
2	4% milk	35.1	37.9	38.2	28.2	35.5	37.7
	Forage D M.	29 6	28.1	24.5	20.4	23.5	20.0
	Grain D. M.	____	4.3	10.4	____	5.6	9.3
	Ration D. M.	29.6	32.4	34.9	20.4	29 1	29.3
3	4% milk	29.3	32.1	36.0	24.9	34.1	36.2
	Forage D. M.	29.3	27.7	22.9	19.7	24.0	20.2
	Grain D. M.	____	3.7	9.2	____	4.3	8.5
	Ration D. M.	29.3	31.4	32.1	19.7	28.3	28.7
4	4% milk	27.7	31.2	33.0	27.0	33.6	36.7
	Forage D. M.	27.9	28.2	23.8	22.2	25.6	21.5
	Grain D. M.	____	3.3	7.3	____	3.8	7.9
	Ration D. M.	27.9	31.5	31.1	22.2	29.4	29.4
5	4% milk	29.4	32.4	33.5	24.2	31.6	35.1
	Forage D. M.	28.4	29.1	24.2	24.3	26.6	23.0
	Grain D. M.	____	3.2	7.0	____	3.8	8.1
	Ration D. M.	28.4	32.3	31.2	24.3	30.4	31.1
6	4% milk	26.9	29.8	29.9	19.2	27.8	30.3
	Forage D. M.	28 7	28.6	23.2	24.7	28.1	23.5
	Grain D. M.	____	2.9	7.1	____	3.7	7.6
	Ration D. M.	28.7	31.5	30.3	24.7	31.8	31.1
7	4% milk	24.4	27.2	27.9	15.2	25.1	28.3
	Forage D. M.	29.5	28.6	23.5	23.2	27.0	23.7
	Grain D. M.	____	2.5	5.7	____	2.4	4.9
	Ration D. M.	29.5	30.1	29.2	23.2	29.4	28.6
8	4% milk	27.6	29.7	30.8	14.8	24.7	27.9
	Forage D. M.	29.2	30.2	24.7	18.0	20.2	18.3
	Grain D. M.	____	2.7	6.2	____	1.7	4.9
	Ration D. M.	29.2	32.9	30.9	18.0	21.9	23.2
9	4% milk	25.2	26.7	28.3	12.8	23.4	28.0
	Forage D. M.	28.3	29.5	24.0	18.5	20.9	19.3
	Grain D. M.	____	2.0	5.4	____	1.1	4.0
	Ration D. M.	28.3	31.5	29.4	18.5	22.0	23.3
Av.	4% milk	29.5	32.0	33.1	22.0	30.4	32.8
	Forage D. M.	28.7	28.4	23.7	21.2	24.3	21.1
	Grain D. M.	____	3.3	7.7	____	3.3	7.1
	Ration D. M.	28.7	31.7	31.5	21.2	27.7	28.3

APPENDIX III.—Daily Dry Matter Intake, 4% Fat Corrected Milk Produced, and Weight Change for 1957

Treatment	Daily Dry Matter Intake		Daily 4% F. C. M.	Net Weight Change
	Total	Forage		
	(lb.)	(lb.)	(lb.)	(lb.)
Groups				
Soilage				
No Grain	27.6	27.6	31.1	0
Half Grain	29.5	24.8	37.3	+ 8
Full Grain	31.5	24.7	35.1	+49
Average	29.5	25.5	34.6	+19
Silage				
No Grain	18.7	18.7	23.3	—54
Half Grain	20.6	17.3	26.7	—27
Full Grain	22.4	16.0	28.1	— 3
Average	20.6	17.3	26 0	—28
L S. D. Forage Means				
.05	2.1	1.5	3.2	44
.01	3.4	2.5	5 3	N. S.
L. S D. Grain Means				
No Grain	23.2	23.2	27.2	—27
Half Grain	25.1	21.1	32.0	—10
Full Grain	27.0	20.4	31.6	+23
L. S. D. .05	2.4	1.9	N. S.	N. S

APPENDIX IV.—Daily Dry Matter Intake, 4% Fat Corrected Milk Produced, and Weight Change for 1958

Treatment	Daily Dry Matter Intake		Daily 4% F C M	Net Weight Change
	Total	Forage		
	(lb)	(lb)	(lb)	(lb)
Groups				
Soilage				
No Grain	28 7	28 7	29 5	+22
Half Grain	31 7	28 4	32 0	+65
Full Grain	31 5	23 7	33 1	+31
Average	30 6	26 9	31 5	+39
Silage				
No Gra n	21 2	21 2	22 0	—60
Half Grain	27 7	24 3	30 4	—79
Full Grain	28 3	21 1	32 8	—23
Average	25 7	22 2	28 4	—54
L S D Forage Means				
05	3 8	2 9	1 8	42 5
01	N S	N S	2 9	70 4
L S D Grain Means				
No Grain	25 0	25 0	25 8	—19
Half Grain	29 7	26 4	31 2	— 7
Full Grain	29 9	22 4	33 0	+ 4
L S D 05	2 7	2 9	5 2	N S